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SPRAYING FOR THE CONTROL OF WILD MORNING-GLORY WITHIN THE FOG BELT

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A comprehensive series of experiments on the control of weeds by means of chemicals has been carried on since the fall of 1915. While the experiments are still in progress, the results so far reached warrant the following recommendations for the control of wild morning-glory.[1]

The remarkable potency of arsenic in destroying the roots of wild morning-glory when the chemical is applied in small quantities to the leaves and stems of the plant, is the most important fact thus far determined in the investigation. This was first observed at Centerville and later in Ventura County in the fall of 1915, but not again until the late summer and fall of 1916. The destruction of the roots in this manner takes place only under restricted conditions, however. The main factors influencing the results appear to be the condition of the plants and the weather. Thus far, no way has been found to make practical use of this fact *except in the coast regions.* Only one set of experiments was made in a semi-arid climate (Davis). There the results were mostly negative, so that as yet the procedure is *not recommended for climates away from the coast.*

The effectiveness of a dilute arsenical spray for the control of California's most troublesome weed on agricultural land within the fog belt, without injury to the soil, appears to have been established. This statement is based upon the repetition of predicted results at Centerville on scheduled time, and the accumulation of confirmative data through the experiments at Spreckels and at Berkeley.

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[1] A report of progress in the investigations will be published later as a Station bulletin. This will contain a full account of the experiments and, as soon as issued, may be obtained upon application to the Director.

PREPARATION OF THE SPRAY

Arsenic trioxide (the "white arsenic" of commerce) is the basis of the spray and is used as the unit in comparing concentrations. This is not sufficiently soluble in water for use as an herbicide to the best advantage. It is customary to combine it with sal soda, soda-ash, caustic soda, or concentrated lye, with which it forms compounds readily soluble in water. The following table may be of use in indicating the approximate weights of common solvents for arsenic trioxide:

	Solvent, parts	Arsenic trioxide, parts
Sal Soda or Washing Soda ($Na_2CO_3.10\ H_2O$) (crystalized sodium carbonate)	2	1
Soda-ash (crude sodium carbonate), anhydrous	1	1
Caustic Soda (NaOH) (sodium hydroxide)	1	2*
Concentrated Lye (mixture of NaOH and Na_2CO_2)	1	2

* A soluble arsenical can also be made by using one part of caustic soda to four parts of arsenic trioxide. Such a solution, however, has a tendency to separate crystals on standing.

If sal soda or soda-ash is used, it is necessary to boil the mixture fifteen or twenty minutes before the arsenic is dissolved. If caustic soda is used, little or no boiling is required. In either case, however, a corrosive chemical is formed, known as sodium arsenite (or arsenite of soda), which is readily soluble in water and is even more poisonous than the original arsenic trioxide.

Sodium arsenite may be purchased ready-made as a white powder. There are also on the market a number of "weed-killers" which are concentrated solutions of sodium arsenite. Neither the sodium arsenite nor the commercial "weed-killers" can be depended on as having a uniform amount of arsenic. The "white arsenic" of commerce, however, can be readily purchased of 95 to 99 per cent purity, according to many analyses made by the Insecticides and Fungicide Laboratory. It is therefore recommended that a stock solution of sodium arsenite be made up with arsenic trioxide according to the directions below, or that the purchaser insist on the dealer's giving a definite guarantee of the arsenic content of sodium arsenite or of any prepared arsenical "weed-killer." The handling of arsenic and corrosive substances by one unfamiliar with the behavior of chemicals and the bringing of poisons into the kitchen are practices to be avoided. The preparation of small quantities is troublesome and the saving usually does not warrant giving the necessary time and attention.

The Stock Solution.—The preparation of the poison presents no great difficulties or dangers if adequate facilities are available out of doors and the operator is at all familiar with the handling of chemicals. If a considerable amount is to be prepared the saving will be quite material. Extra precautions, however, should be observed at all times in the manipulation of arsenic.

Caustic soda (sodium hydroxide), or a good grade of concentrated lye, is much more active in dissolving arsenic than either sal soda or soda-ash and much less is required, although the cost per pound is greater. Very little heat is required in the preparation of sodium arsenite by means of these materials. If made in large quantities (five gallons or more) the use of heat is unnecessary. The following formula for the preparation of the stock solution is preferred on account of its simplicity:

Granulated Caustic Soda (98 per cent)	10 pounds
White Arsenic (arsenic trioxide, 99 per cent)	20 pounds
Water, to make	5 gallons

The solution may be made as follows: Dissolve the caustic soda in about two gallons of water in a metal or wooden vessel (preferably iron) and while still hot, add the dry arsenic, about a pound at a time, at a sufficient rate so that the solution is just at the point of boiling, but does not actually boil. Stir continuously during the addition of the arsenic and until all is dissolved. Considerable heat is produced by dissolving the caustic soda. Additional heat is furnished by the chemical reaction involved in the union of the caustic soda with the arsenic to form sodium arsenite. After all the arsenic is dissolved, let the solution cool and add water to make exactly five gallons.

Caution.—Do not add cold water to the hot solution. An explosion may result as the solution is hotter than the boiling point of water.

If, for any reason, the arsenic fails to dissolve without the use of heat, a solution can be made by warming the mixture, unless the materials are of low grade. If hard water is used there will be some insoluble matter in suspension, but it may be disregarded unless present in large amount.

The above makes a convenient stock solution for diluting to any desired strength; that is, each gallon contains four pounds of arsenic trioxide; a quart, one pound; each fluid ounce contains one-half ounce of arsenic trioxide.

The above formula is preferred, although other formulas may be

made use of by making calculations on the basis of their content of arsenic trioxide. It is inadvisable to use sodium arsenite as the basis of calculations on account of the variation in the active constituent, arsenic. Strictly speaking, elementary arsenic should be used as the unit of comparison, but as the trioxide is used as the raw material, it is permissible and more convenient to use the latter as a unit.

The cost of materials for the preparation of the stock solution is about fifty cents per gallon when arsenic sells at eight cents, and caustic soda at ten cents per pound. The price of arsenic has recently advanced to twenty-three cents per pound and caustic soda has also advanced. A revision of prices does not seem warranted at the present time in view of the unsettled market conditions.

Diluting the Stock Solution.—The spray recommended for use against the wild morning-glory is made up by diluting the stock solution at the rate of one gallon to one hundred gallons of water. A solution of approximately the same concentration can be made up for small operations by diluting four fluid ounces (one-fourth pint) of the stock solution with three gallons of water. The sprays should be well stirred to insure uniform distribution of the poison. The concentration of this spray is equivalent to four pounds of arsenic trioxide per hundred gallons. Much weaker sprays than the above proved to be ineffective; stronger concentrations did not appear to be more effective, and possibly less. The stronger sprays in some instances seemed to collapse the tissues of the vines and stop the circulation of the sap before the poison had its full effect on the roots.

When to Spray.—October has been tentatively selected as the best month to spray for the wild morning-glory. The plants are more apt to be in the proper condition to receive the spray at that time and the killing frosts do not usually occur until later. The spray may be applied in November or possibly later if the vines have not been killed by the frosts.

Anyone contemplating using the spray in October or November should let the vines grow undisturbed after July or August, as the vines must be at least three or four months old before the spray will affect their roots. A luxuriant growth of vines (that is, a large absorbing surface) is favorable to the destruction of the roots. Damp, cloudy, or foggy weather is also favorable.

Application of the Spray.—Two types of hand sprayers were used in the experiments without preference: one commonly called a bucket spray pump, and the other a pressure sprayer. Any type of sprayer throwing a fairly fine spray may be used for operations on a small scale. A power sprayer would be desirable for large undertakings.

The spray should be applied to the vines in sufficient quantity to thoroughly moisten them, but not to drench them. No good can be accomplished by allowing any of the spray to fall on the soil. The quantity of spray required will vary according to the density of the infestation. A heavy infestation will require about three gallons of spray per fifty yards, or three hundred gallons per acre.

Possibilities and Limitations of the Method.—The experiments have shown that even as many as six successive applications of the spray described above produced no injurious effect on the soil. The foliage of all plants, however, is severely injured by the spray. The application of the method is therefore limited to cases in which the spray can be applied to the morning-glory without coming in contact with the foliage of crops. The treatment can be given on infested land which is utilized for the growing of any annual crop which is harvested by July or August. The spray can be used in orchards or vineyards if care is exercised to prevent it from reaching the trees or vines.

The method described can not as yet be said to be one of *eradication.* It has been demonstrated, however, that 85 to 90 per cent. of the morning-glory roots on the plots near the coast can be killed to a depth of four feet or more by the application of a properly-timed spray to *mature vines.* New sprouts will emerge from the stubs of the partially killed roots and will eventually reach the surface and produce new vines. Under these conditions they are very puny, the leaves being only about one-fourth of the normal size and of a sickly yellowish color. The new growth is quite different from the normal trailing vine. When the new shoot reaches the surface, a thick clump of erect branches is produced not more than eight or nine inches in length. The majority of the new shoots consume from seven months to one year in reaching the surface so that a crop can be well established on the land or an early crop harvested without serious interference from the weed.

The abnormal condition of the vines originating from the stubs of the partially destroyed roots and the enfeebled condition of these root stubs, lead one to believe that an annual fall spraying may eventually eradicate the weed. At any rate, the cost of the materials for the spray treatment does not exceed $1.50 per acre in normal times, nor $5.00 per acre at "war prices," and is therefore practicable as a *control* measure.

While the root systems of wild morning-glory can be destroyed to the extent and under the restricted conditions previously discussed,

the vines may be easily destroyed and prevented from maturing seeds by the application of the arsenical spray at any time of the year. The destruction of the vines in this manner has taken place in both the dry and the somewhat humid climates in which the experiments were made.

DANGER IN USING ARSENIC

The writer is fully aware of the danger connected with the use of arsenic. For this reason, a definite effort is being made to find some less poisonous herbicide which may be recommended for the control of weeds. Thus far, however, no substance has been found to compare at all favorably with arsenic as a plant poison when the cost is taken into consideration. If this powerful agent of destruction is to be employed as a tool for the control of weeds, the user must always be alert to the fact that it is a destroyer of both animal and plant life, the harmful and beneficial alike.

Harmless Appearance.—Most arsenicals, when dissolved in water, make colorless and odorless solutions having only a slight taste. This harmless appearance greatly adds to the danger of accidental poisoning.

Danger to Live Stock.—Those using the method described in this circular are warned to keep stock away from the sprayed morning-glory patches. Sheep and swine are very fond of the weed. Forage plants, when sprayed with arsenicals, seem to be especially attractive to live stock. Cattle, horses, and even poultry have been poisoned by eating Johnson grass which had been sprayed with an arsenical herbicide.

Arsenic Carried by Smoke.—When a rank growth of vegetation has been destroyed with a heavy arsenical application, considerable caution must be used, if it is desired to burn the brush. The arsenic would be very readily volatilized in this manner and would be carried in the smoke. It is thought that a poisonous dose of arsenic could be easily inhaled in this way.

Danger to Crops.—The action of sodium arsenite is more severe on broad-leafed plants than on grasses, although it is a violent poison to practically all plants.

Effect on the Soil.—The experiment station is observing the effect of arsenic and other chemicals on the soil. Arsenic is accumulated in the top layer of the soil and is not easily washed out by rains, so that it should be *sparingly used* on agricultural land, and only by the method previously described.

Notwithstanding its poisonous nature, however, arsenic may prove a valuable aid to the farmers of the state in the control of some of the most troublesome weeds, *if used with discretion.*

TREATMENT TO BE USED IN CASE OF ARSENICAL POISONING

A request was made of the California State Board of Pharmacy to recommend the most approved procedure in case of arsenical poisoning. Mr. Louis Zeh, Secretary of the Board, has kindly furnished the following:

First Aid.—The first thing to be done in case the fluid should be taken by mistake is to mix two teaspoonfuls of mustard with a teaspoonful of salt in a cupful of water, and take the whole at one draught. If vomiting is not produced in ten minutes, repeat the dose, and follow with two or three cupfuls of warm water to promote vomiting; then give the antidote.

Antidote.—The antidote to be used in case of poisoning is the official antidote for arsenic in the U. S. Pharmacopoeia. This may be made as follows: Take two bottles, each holding a quart; place in one of them one hundred and fifty grains (150) of magnesium oxide, and fill it two-thirds full with water. Into the other pour one and a third ounces of the solution of tersulphate of iron U. S. P. and fill the bottle one-quarter full with water. When the antidote is to be used, shake the bottle containing the magnesia till the contents are suspended in the water; then add the contents of the bottle containing the solution of iron to the bottle containing the magnesia and shake well. Give half a tumbler of this mixture for a dose. After remaining in the stomach about five minutes it should be removed by vomiting or by using the stomach pump. This treatment should be repeated three or four times, leaving in the stomach one-half of the last dose.

Precautions.—The hands should be protected with rubber gloves or smeared with lanolin (wool fat), or some other adhesive grease, to prevent absorption of the liquid which produces poisonous effects if applied to skin equally as if taken internally.

The face should be greased to protect it as well as the hands. To protect the eyes goggles should be worn.

Treatment of External Poisoning.—If the liquid comes in contact with open wounds or sores, they should be washed with water and soap, rinsed with clean water, and the antidote applied. Let this remain on the hands half an hour, and then remove with clean water.

If any of the liquid should get into the eyes, they should be washed with water, and a bland oil, like sweet almond, olive, cotton seed, or salad oil, put into the eyes. Afterwards bathe the eyes with a warm solution of boric acid.

Further Treatment.—The antidote is a chemical antidote and forms a less soluble compound with the arsenic, but should always be removed as it would eventually be absorbed and produce poisoning. Mucilaginous drinks should be freely taken to relieve the intense thirst and burning produced by the arsenic.

The subsequent treatment should be left to a physician who should be called immediately.

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REPORTS

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